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The Power of Waste Management and Solar Panel as Eco Energy Alternative through the Collaborative Approach by Governments and Organizations

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Abstract

This scholarly article extensively explores the intricacies of global energy systems while providing a comprehensive analysis of emerging technologies that can address escalating energy needs sustainably. The study employs advanced qualitative data tools and detailed observation methods to support these findings. Moreover, the report highlights waste energy and solar panels as two of the most reliable and sustainable sources of renewable energy. The paper emphasizes how Neoliberalism approach, promoting collective collaboration, innovation, and cooperation among stakeholders in the global energy sector, can lead to the implementation of environmentally friendly and renewable energy sources. This approach aims to reduce the energy crisis for future generations and has the potential to transform our current fossil fuel-dependent system into one based on diverse renewable resources. Addressing climate change concerns, including pollution and non-renewable sources, remains an essential aspect of sustainable energy research worldwide, with a focus on low-cost technology utilizing locally accessible materials.

Key Words: actors in energy, energy, energy crisis, energy resilience, fuels, solar panels, waste management, climate change, renewable energy, energy policy

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INTRODUCTION

Sustainable development and climate change adaptation are at the forefront of discussions worldwide, with "energy resilience" being an increasingly relevant term. To withstand the detrimental effects brought about by climate change, natural disasters, and other shocks on energy systems, it has become imperative for governments across the globe to prioritize ensuring energy resilience (Gomez, 2018). There has been a growing interest from environmental regulations towards embracing strategies that can help communities adapt better during times of stress related to changes in costs or political and economic implications projected for future events (Vallejo & Mullan, 2018, p.2). Therefore enhancing energy resilience becomes key not only for survival but also as an important strategy for mitigating challenges posed by climate-related shocks because reliable access to affordable sources of power ensures sustained progress without fail even during crises. To deal with the effects of climate change and other associated challenges, it is crucial to create plans that anticipate disruptions and minimize risks from disasters. It should be noted that energy resilience involves various social, cultural, and economic processes across all levels of stakeholders involvement with local governments. Given this context, sustainable practices in communities are essential where there continues a marked increase in energy demand globally. Governments must strive towards building an infrastructure for diverse distributed sources rather than relying primarily on centralized fossil-fuel-driven systems which can lead to dependence issues over time. One way this may happen could be through prioritizing renewable alternatives like wind power installations or technological innovations such as waste-based energies besides solar technology implementation, thus providing for better resilience measures against finite resources depletion problems by investing in renewables instead. Additionally, reinforcing necessary infrastructure against natural calamities and reserving adequate fuel supplies will strengthen long-term resilient progress too. As the demand for sustainable development and climate change mitigation rises, the importance of energy resilience has also grown rapidly. Governments must prioritize building resilient energy systems by encouraging decentralized renewable power sources adoption, maintaining sufficient fuel reserves, and reinforcing infrastructure to withstand natural calamities.

The harmful effects of fossil fuel dependency transcend borders and affect all nations, regardless of their development status. While developed countries struggle with manufacturing scarcity due to their heavy reliance on non-renewable energy sources, developing nations fear depletion over time because their larger population requires an increased supply. Unfortunately, these negative impacts impact developing countries more severely as they lack the necessary resources for innovative solutions in comparison to their wealthier counterparts, who have easy access to skilled resources that allow them to implement alternative options effectively.

Countries globally must prioritize exploring alternative energy sources, as fossil fuel reliance harms the environment and poses a risk to energy systems. Developing countries, like India, with high population growth require sustainable energy solutions that do not harm air quality or contribute to pollution problems across borders induced by rapid urbanization. Similar to India, Indonesia is among the most populated countries in Southeast Asia and worldwide. Consequently, it faces the challenge of a population-energy supply imbalance that may cause severe social impacts if left unresolved and requires urgent attention (Park, 1983, pp. 93-110). Moreover, disruptions such as COVID-19 have already had damaging effects on the economy and infrastructure of Indonesia. To alleviate these challenges successfully, various stakeholders, like the Asian Development Bank as part of South-South Cooperation, are working towards providing loans aimed at strengthening essential sectors in developing nations like ours.

The main reasons for the global energy crisis are limited natural gas supplies and decreased oil production due to rising energy demand. Given that many countries are in recession, the situation appears to be escalating. Not to mention the impact on energy prices such as coal, natural gas, and oil, which increased by a factor of two to four in mid-2022 compared to 2019. Moreover, there is a restricted supply of natural gas or a lack of natural fuels, yet the public demand seems so high that communities overuse their energy systems. This energy crisis may act as a catalyst for significant and long-term changes in affected nations, with the potential to expedite the transition to more sustainable and safe energy systems. The current energy crisis is causing extremely broad and complicated shocks with actors ranging from governments to private companies seeking solutions to the challenges posed by climate change and resource depletion. The natural gas, coal, and electricity markets suffered the majority of the damage. Mistreatment of power generation has also contributed to the energy crisis, and illegal fuel import and export activities

continue to grow among all parties. It is not impossible that it will have a bearing on and impact on global economic stability as well as energy itself.

As renewable energy sources continue to gain momentum, traditional fossil fuel industries are being forced to adapt and innovate in order to remain competitive. However, in some countries, even with the lower cost of the technologies, the deployment of renewable energy is challenging because of a lack of sufficient human resources. Despite the presence of several international organizations and projects aimed at tackling energy-related challenges, these efforts have been fragmented and, at times, redundant. This lack of consistency can impede the capacity of the international community to respond effectively to energy emergencies. It sums up the absence of a comprehensive, coordinated strategy for global energy governance.

Another concern is energy security, which relates to ensuring consistent access to energy supplies. This is especially critical for countries that rely substantially on energy imports. According to the Sebastian (2014), a variety of issues, including political instability, natural disasters, and price volatility, are threatening energy security. This makes energy supply and demand difficult to anticipate and control, and it can worsen energy crises.

That is why developing countries like Indonesia, which face an energy crisis, need funding support from organizations like ADB to improve their infrastructure. Developed countries should facilitate innovative solutions specially tailored for developing states located predominantly in global south regions such as ours (International Renewable Energy Agency, 2023). This would allow for fostering South-South cooperation, which becomes indispensable when addressing crises related to ever-growing energy demands affecting those communities most vulnerable in the world today, primarily through no fault of their lack of resources compared with others living elsewhere around them where conditions improve or evolve much faster than here. Therefore, international cooperation and support must be given to developing countries. Through collaboration between governments, consumers, and innovative entrepreneurs, we can effectively address the global energy crisis.

The COVID-19 pandemic has shown us how interconnected our supply chains are and underscored the need for long-term strategies focused on renewable resources to ensure stable power sources amid geopolitical tensions and adverse climate conditions. To build resilience in these uncertain times, we must prioritize investment in renewable resources over finite ones to secure a more sustainable

future for generations to come. The global energy crisis is a multifaceted issue with various underlying causes, including geopolitical tensions and climate change-induced calamities. To address this crisis, effective multi-level governance frameworks prioritizing sustainable power alternatives must be implemented alongside behavioral changes among consumers and coordinated solutions by governments.

Furthermore, it is crucial to recognize that achieving sustainable solutions requires not only technological advancements but also significant behavioral changes. Therefore, policymakers and stakeholders must work together to encourage the impact of sustainable energy use and promote the adoption of emerging technologies while minimizing greenhouse gas emissions.

Literature Review and Statement of art

During the recent G20 meeting in Bali, Indonesia, there were various productive discussions and ideas that have garnered global attention. As the host country, Indonesia has emphasized the importance of G20 member countries supporting developing nations facing energy crises in order to advance the international commitment to renewable energy. These conversations underscore the significance of addressing energy challenges in developing countries and foster a sense of collaboration among G20 members (Bappenas, 2022, p. 13). It is essential to explore novel approaches and provide assistance to these nations as they transition towards sustainable sources of energy, aligning with their objectives for sustainable development. The continuous pursuit of a global agenda for renewable energy transition holds great value due its potential for mitigating climate change, reducing greenhouse gas emissions, and fostering a more environmentally conscious future for all individuals. By prioritizing renewable energy, we can create new job opportunities, improve energy access, and enhance the overall resilience of economies worldwide. It is imperative that governments, organizations, and individuals work together to accelerate the transition to renewable energy and ensure a greener and more prosperous world for future generations. Collaborations between governments, organizations, and international bodies can involve sharing best practices, providing financial support, and promoting research and development in renewable energy. Additionally, international agreements and policies can play a crucial role in incentivizing the adoption of renewable energy sources and setting ambitious targets for emissions reduction. By working together, we can overcome the challenges associated with transitioning to renewable energy

and pave the way for a sustainable future. These recommendations could shape the strategies of governments and organizations in facilitating renewable energy adoption. For example, governments can provide financial incentives such as tax credits or subsidies to encourage individuals and businesses to invest in renewable energy technologies. Furthermore, organizations can collaborate with research institutions to develop innovative solutions and technologies that can make renewable energy more affordable and accessible for all.

METHOD

In preparing this literature review, two research methods were used that hopefully answer the question: qualitative data analysis and observation techniques in data collection techniques. Qualitative data analysis is the process of organizing, analyzing, and interpreting non-numeric data to produce informative information for developing important research proposals and needs. By carefully analyzing patterns and relationships in the qualitative data, researchers can uncover valuable insights that inform research proposals and address specific research needs. Peer debriefing is another approach where researchers discuss their findings with colleagues to gain different perspectives and ensure the trustworthiness of their conclusions. Observation in the social sciences involves systematically observing and recording behaviors or interactions within a specific context. It allows researchers to gather rich qualitative data that can provide a deeper understanding of social phenomena. Audiometry, similarly, involves actively listening to or observing language use in order to gather valuable information about language acquisition and proficiency.

The research is further supported by the Neoliberalism approach, which claims that, although the international system is considered anarchic, in which states act independently and rationally to further their own interests, international cooperation can still emerge through the establishment of norms, regimes, and institutions (Joshua S. & Jon C., 2013-2014, pp. 88-122).

- Norms refer to rules, shared beliefs, and actions that the international community considers appropriate or inappropriate. These norms can influence state behaviour and encourage them to behave more cooperatively.
- Regime refers to the set of rules, procedures, and institutions that govern interactions between nations in a particular field, such as international trade, the environment, or security. These regimes can help reduce brightness and increase cooperation.

- Institution refers to an international organisation, such as the UN, WTO, or a regional organization, that is established to facilitate cooperation between countries. These institutions provide a venue for negotiation and policy coordination.

Neoliberalism holds that, through the establishment and adherence to shared norms, the establishment of regimes, and the use of international institutions, states can cooperate even in systems that are perceived as anarchic, and this can lead to mutual benefits, peace, and stability in international relations.

DISCUSSION

Generating ecologically beneficial, non-polluting renewable energy is a challenge for countries dealing with global energy crises. To combat and avert ongoing conflicts, which have the potential to have a substantial influence on adjacent countries, including Indonesia. We require something known as renewable energy. This renewable energy is one of the methods that countries utilize to store renewable energy. As an outcome, it is possible to re-explore and develop while transitioning to various energies as needed. We clearly understand that the impact will be significant in the future. Renewable energy must be inexpensive, practicable, and simple to implement. Generating ecologically beneficial, non-polluting renewable energy is a challenge for countries dealing with global energy crises. In terms of energy, developed countries such as Japan, Sweden, and China have effectively created alternate energy sources while maintaining existing labor systems and avoiding economic crises. As a result, Indonesia is one of the countries witnessing the situation unfold. **Waste management energy** and **solar panels** are two examples of alternative energies that can be used.

Waste Management

Waste management energy is an efficient method of converting waste into productive power systems. In Indonesia, Presidential Decree 58/2017 designated waste-to-energy as a national strategic initiative. This elevates the role of natural resources even more and necessitates a greater focus on the empowerment of current mechanisms (International Trade Administration, 2022). Waste sorting programs (for organic and inorganic waste) are well-known to be unsuccessful because they end up in *Tempat Pembuangan Akhir* (TPA). Indonesians should do more to conserve energy resources as a whole. In addition to stakeholder involvement, waste management practices should be examined, as waste disposal

in Indonesia is decreasing year after year. Instead of preserving this waste, it is preferred to convert it into energy. If the waste can not be handled with the available resources, it may be transported to other countries, such as Sweden, which has had success converting waste into energy. Sweden has no energy resources and they have to import it from other countries. As a consequence of this collaboration in energy management, Indonesia could become one of the clients of Sweden. It is a win-win solution for Sweden and Indonesia. Sweden will comply with the waste as what they needed and Indonesia will take the beneficial profit from the outcomes. Waste production in Indonesia will, of course, continue, so that revenue may be invested to construct an energy-producing system.

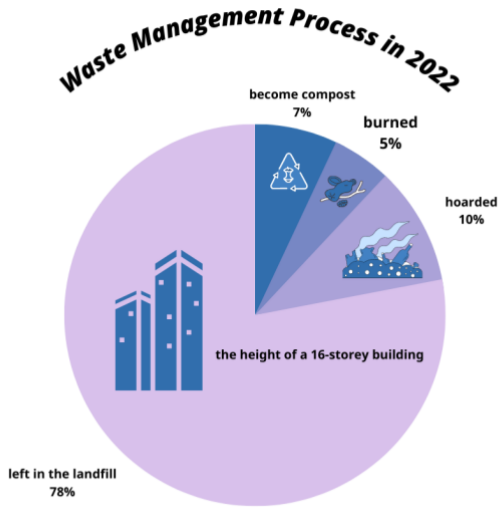

Figure 1. Waste Management Process in 2022 by Waste4Change.

The illustration above depicts where and how waste has been managed thus far. In Indonesia, the waste management problem remains complicated. A lot of waste is simply dumped or acquired, which has a negative influence on humans and environmental sustainability. Indonesia is the world's fourth-largest country, with a population of 273,523,616 people. Every square kilometer contains 100 thousand individuals. Waste4Change reports that they collect 175 thousand metric tons of trash per day. Only 7.5% can be eliminated (Amanda, 2018). So, one strategy to reduce the waste pile is to convert it into an alternate energy material. Naturally, this waste will be managed in a wide range of ways, including being crushed or divided into pieces, used as fertilizer, then turned into machine labor, and so on.

Solar Panel

Solar panels are the most rational option for countries throughout the world. Learn from the participation of southern countries that are getting enthusiastically inspired about climate justice and energy transition capacities. The growth of practices and energy transitions, as well as emerging global commodities networks, help rebuild the unequal relations between the North and South. The initial entity will be the technological host, while the latter will be the provider and will be at the bottom of the supply chain. Perhaps concentrating on one region that gets used as a power site is the solution for several countries (Indonesia and Europe). This program has areas that are neglected and prominent. Consider the solar panel used by Sumba. They target farmed barren land to establish solar panels, which are then distributed as energy by the community. The government, as one of the actors involved, only comprehends regulatory regulations and must consult with various actors. Indonesia is joining the South-South bloc and needs to prepare for this issue (Rachmawati et al., 2023, p.2). If we rely exclusively on fossil fuels and do nothing in return, there could be long-term consequences, necessitating pressure from the global community. The government needs to act fast by implementing effective monitoring and evaluation systems to maintain its regulatory framework. However, the current management of regulations in Indonesia has been inadequate so far, putting us at risk. The government needs to recognize and promote the unused potential of solar energy on our lush tropical islands. Recent studies demonstrate how off-grid solar systems have provided access to electricity for individuals living beyond their national provider's reach, particularly through grassroots organizations like Sumba Sustainable Solutions offering affordable imported home solar systems with added benefits such as charging cell phones or powering light bulbs etcetera with monthly fees (Associated Press, 2023). Eastern Indonesia, with its heavy dependence on diesel generators, is poised to adopt renewable energy sources dramatically and retire existing plants due to the government's targeted programs. Going green should not be limited only to populated areas as uncontrolled biodiversity loss will have an irreversible impact on the Earth if unchecked. ADB's $500m loan for Indonesia's energy transition will boost renewable sources, including solar power. Highlighting the effectiveness of solar on the islands could speed up the transition and enhance socio economic progress (The Asian Development Bank (ADB), 2022).

To overcome the threat of a global energy crisis in Indonesia, collaborative efforts between state and non-state actors are essential in the area of waste energy management. Developing policies and rules for waste energy management,

including incentives and subsidies to encourage investment in the field, is a critical responsibility of the Indonesian government. Additionally, the government funds research and development of cutting-edge technologies for waste energy management. Another significant state actor who might have a major role is *Perusahaan Listrik Negara* (PLN), which is in charge of procuring energy for Indonesia. PLN may collaborate with private sector businesses and other industry partners to create waste energy management strategies and support the development of new waste energy sources.

On the other hand, private sector businesses, such as multinational companies, are very important in the creation and application of waste energy solutions. They can work with the government, PLN, and other stakeholders to develop waste energy solutions that are economically efficient and meet environmental standards. Private businesses, such as those in the renewable energy industry or those that offer waste management services, can also invest in new technologies and innovations related to waste energy management. Finally, partnerships for waste energy management initiatives in Indonesia may also come from international organizations and NGOs. These parties, such as the United Nations Environment Programme (UNEP) and International Energy Agency (IEA), could offer Indonesian waste energy management initiatives technical support, financial backing, or other resources. Specifically, in the case of waste energy management in Indonesia, the UN might act as a mediator between the Indonesian government and other nations that are willing to provide financial support for its energy development programs. One way the UN can help this process is by sharing technical skills and knowledge about waste-to-energy technology and best practices. The organization can provide technical assistance and capacity building to the government of Indonesia and relevant stakeholders through its various specialized agencies and programs, such as the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the United Nations Industrial Development Organization (UNIDO).

Further, the United Nations might also help nations mobilize financial resources from industrialized nations and international financial institutions to support state actors energy development initiatives. The organization can foster collaboration and partnerships between the Indonesian government and other nations or institutions that are able to provide financial support, such as the Green Climate Fund, the Global Environment Facility, or bilateral partnerships. Additionally, they can advocate for laws and policies that encourage the development of sustainable energy sources and environmental protection, as well as support research and

development in the field of waste energy. In conclusion, cooperation between state and non-state actors is crucial for creating and putting into practice efficient waste energy solutions to address the energy crisis of Indonesia (International Trade Administration, 2022). Overall, the UN can play an important role in assisting state actors with waste energy management and encouraging sustainable energy development.

This study reveals that the roles of global energy actors are critical for developing industrial innovations to maintain energy resilience during an energy crisis. The ability of an energy system to withstand and recover from disruptions caused by natural disasters, cyber-attacks, or other events that affect energy supply is referred to as energy resilience. The global energy crisis, according to any international research conducted by various organizations such as the IEA, UNDP, the World Bank, and IRENA, refers to a situation in which the demand for energy exceeds the available supply. Therefore, the global energy crisis is exacerbated by several gaps in global energy demand, such as;

- Population Growth: The global population is rapidly increasing, which raises energy demand. This growth puts a strain on energy supplies, resulting in an energy crisis.
- Inefficient Energy Use: Many countries continue to use inefficient energy technologies that consume more energy than necessary. This inefficiency strains energy supplies and contributes to an energy crisis.
- Dependence on Fossil Fuels: Fossil fuels are the primary energy source for many countries, and yet their availability is limited. The reliance on fossil fuels strains energy supplies and leads to an energy crisis.

To tackle the energy crisis in the world, policymakers must adopt a multifaceted strategy to fill global energy demand gaps. The following are some of the policies being initiated by global energy actors to address the global energy crisis:

- Renewable energy: Solar, wind, and hydropower are being promoted by policymakers. This strategy reduces reliance on fossil fuels and promotes the use of sustainable energy.
- Energy Efficiency: Energy-efficient technologies that reduce energy consumption are being promoted by policymakers. This approach contributes to closing the gap between energy demand and supply.
- Diversification of Energy Sources: Policymakers are encouraging the use of alternative energy sources such as nuclear energy, biofuels, and waste energy.

This strategy contributes to the diversification of energy sources and the reduction of reliance on fossil fuels.

- Energy Conservation: Policymakers are encouraging people to conserve energy by turning off lights and appliances when they are not in use. This approach reduces energy demand while also bridging the supply-demand gap.

Actors can also invest in energy storage and smart grid technology. Collaboration among actors in the global energy market can increase energy resilience and lessen the danger of energy shortages during a crisis. Since converting waste into energy through various technologies is a crucial component of renewable energy policy, numerous international treaties and regulations recognize this fact as well as include waste-to-energy as a type of renewable energy that can contribute to reducing greenhouse gas emissions and achieving sustainable development goals. One of the most important accords addressing waste-to-energy is the United Nations Framework Convention on Climate Change (UNFCCC). The accord, which was signed in 1992, attempts to prevent harmful human involvement with the climate system. The accord mentions waste-to-energy as a type of renewable energy that can help reduce greenhouse gas emissions. Another notable agreement that recognizes the potential of waste-to-energy in lowering greenhouse gas emissions is the Paris Agreement, which was signed in 2015. The accord aims to keep global warming well below 2 degrees Celsius above pre-industrial levels. The agreement says that waste-to-energy is a type of renewable energy that can help meet such a goal. The European Union (EU) Renewable Energy Directive (RED II), passed in 2018, provides an obligatory renewable energy target for the EU of at least 32% by 2030. The regulation includes waste-to-energy as a sustainable energy source that may help accomplish the goal. Moreover, the United Nations Environment Programme (UNEP) issued the Global Waste Management Outlook in 2015, emphasizing the potential of waste-to-energy technology to contribute to sustainable development and reduce greenhouse gas emissions. Overall, several international accords and directives identify waste-to-energy as an essential component of a renewable energy strategy to promote sustainable development and contribute to a cleaner and more resilient energy system by diverting waste from landfills and generating energy from it.

We encourage each country to examine its accessibility and areas that may be a liability for their own future in order to change such actions and regulations. Even if the resources are not affordable for some developing countries, we believe that the transition to an eco-friendly future may be accomplished progressively. The

only thing that is required is public knowledge and awareness, discipline, and significant action supported by state actors, specifically the government.

Despite all those accords, only a few countries believe that renewable energy can be sustained by utilizing waste energy. This waste can be generated by a variety of activities, including industrial operations, agricultural waste, and municipal solid waste. Actors can improve the availability of energy sources while also reducing waste by transforming waste into energy. This can aid in the diversification of energy sources, the reduction of reliance on fossil fuels, and the improvement of energy resilience. Moreover, waste-to-energy technology can help reduce greenhouse gas emissions and improve air quality, both of which can have a substantial impact on public health.

Actors in the global energy industry may contribute to a more sustainable and resilient energy system by using waste energy. It is true that waste energy may be a vital resource for maintaining energy resilience, and there is technology available for capturing and using waste energy. The extent to which waste energy can be used to address energy resilience challenges, on the other hand, is determined by a number of factors, including the type and quantity of waste energy available, the cost of capturing and utilizing that energy, and the existing infrastructure to support waste energy recovery and utilization.

While waste energy may appear to be an accessible resource for energy resilience, there are many significant challenges to its successful usage. Some of the reasons why global energy industry actors may not effectively use waste energy include:

- High costs: Capturing and utilizing waste energy can necessitate significant upfront investment in infrastructure and equipment, which may be prohibitively expensive for some energy sector actors.
- Technical Struggles: Some types of waste energy are difficult to capture and use effectively, necessitating the use of specialized equipment and expertise. This can make it difficult for actors in the energy sector to effectively utilize wasted energy resources.
- Regulatory Limitations: In some cases, regulations and policies may make capturing and utilizing waste energy difficult or expensive for actors in the energy sector. For example, there may be restrictions on the use of certain types of waste energy, or regulations that necessitate lengthy permitting processes in order to capture and use waste energy.

- Lack of Awareness: Some energy sector actors may be unaware of the potential benefits of waste energy utilization, or they may lack the necessary knowledge or expertise to capture and utilize waste energy resources.

If global energy actors want to effectively use waste energy as an innovation to maintain energy resilience, they can take several steps:

- Conduct a Waste Energy Assessment: The first step in utilizing waste energy is to assess the types and quantities of waste energy available in a given region or energy system. This can aid in identifying potential waste energy sources and estimating the amount of energy that could be generated from them.
- Identify technological solutions: Once potential waste energy sources have been identified, actors in the energy sector can investigate the various technological solutions available to capture and utilize waste energy. Cogeneration, waste-to-energy systems, and heat recovery systems are examples of such technologies.
- Setup Infrastructure and Partnerships: In order to effectively utilize waste energy, energy sector actors will need to build the necessary infrastructure and partnerships to support waste energy recovery and utilization. Developing waste collection and transportation systems, constructing waste energy facilities, and collaborating with businesses and organizations that generate significant amounts of waste energy could all be part of this.
- Increase Awareness and Education: To ensure that waste energy utilization becomes a widely adopted innovation for preserving energy resilience, energy sector actors should raise awareness and education about the potential benefits of waste energy recovery and utilization. Outreach to businesses, policymakers, and the general public, as well as education and training programs for energy professionals, could all fall under this category.
- Address Regulatory and Policy Barriers: Finally, actors in the energy industry will have to identify regulatory and policy barriers that may end up making seizing and utilizing waste energy challenging or costly. Working with policymakers to develop regulations and policies that promote waste energy recovery and utilization, as well as advocating for incentives and subsidies to support waste energy projects, could be part of this.

The problem of sustainable energy requires governments, international organizations, multilateral financial institutions, and civil society, including local communities, business and industry, non-governmental organizations (NGOs), and

consumers, to play critical supporting roles. Partnerships based on integrated and cooperative methods and drawing on actual experience will be sought. According to United Nations Development Programme, setting the appropriate framework conditions and ensuring that public institutions function effectively and efficiently with the rest of society to achieve sustainable development are common denominators across all sectors and geographies. Policies may help promote sustainable development by doing the following:

- Providing a sufficient and cost-effective energy supply
- Promoting energy efficiency.
- Increased adoption of new renewables
- Spreading and implementing additional innovative energy technologies.

On top of that, laws can encourage the development and deployment of innovative finance arrangements to assist energy efficiency initiatives. This might involve offering incentives for private sector investment in renewable energy while also forming collaborations between public and private institutions to accelerate the adoption of advanced energy technology. These policies can help create a more sustainable and resilient energy system by addressing both the supply and demand sides of the energy equation.

CONCLUSIONS

The urgency to move towards a sustainable future is pressing, and we must take bold action now. The current environmental crisis demands an innovative approach that can mitigate the damage caused by emissions while promoting sustainability at the same time. In this context, both waste-to-energy and solar panel technology have emerged as promising solutions with tremendous potential. These technologies offer more than just reducing greenhouse gas emissions; they create opportunities for renewable energy, job creation, and economic growth while protecting natural resources from further depletion. Recognizing their significance in creating a cleaner environment, many international accords and directives prioritize investment in these cutting-edge initiatives. Despite the challenges of implementing them across different nations globally due to various factors ranging from varying levels of development to cultural differences, some countries are already investing heavily in waste-to-energy adoptions or shifting toward solar-powered infrastructure. Indonesia stands among such hopeful examples that hold

enormous potential for adopting efficient sources of clean power, which will be particularly beneficial given its vast rural areas where electricity has been scarce so far but much needed already because they were left out of the mainstream developmental process until now. On reflection, Indonesia's strategic location itself makes it possible to harness solar energy efficiently, putting Indonesia on track towards achieving its vision through sustainable development practices aimed at balanced social-ecological systems, which could only happen if we efficiently utilized the country's renewable energy sources. However, we must acknowledge that there are roadblocks associated with making optimal use of these revolutionary technologies, such as high costs, technical difficulties, regulatory limitations, and a lack of awareness, among many others. To address the challenges of climate change, governments must transition towards greener forms of energy production, such as solar panels.

Other than that, Indonesia could start by conducting thorough assessments of its current waste management process while exploring the prospects presented by solar panels proactively. This requires a systematic evaluation of current waste management procedures and identifying areas for improvement. It is crucial to invest in research and development for technology that supports sustainable practices while also building essential infrastructure through collaborations with both public and private entities. An effective strategy will involve educating communities about clean energy adoption through awareness-raising campaigns that draw attention to the benefits of renewable sources. By implementing these measures, Indonesia can efficiently manage its waste stream while addressing climate change challenges by transitioning toward greener forms of energy production such as solar panels, which hold enormous promise for future electricity generation across multiple sectors nationwide.

To create a cleaner and more sustainable future, it is important to acknowledge that addressing government policies will play an integral role in achieving this initiative's long-term success. In Malaysia, for example, promoting greener technology within municipal waste management systems as well as exploring renewable energy sources would undoubtedly require strong governmental support. The development of clean energy production should also be prioritized by countries such as Indonesia, where there is abundant potential but underutilization of renewable energy resources exists nonetheless.

It is crucial to understand that increasing waste generation has significant negative impacts on our environment, leading to numerous issues with garbage disposal and

problematic components that are unstable at best. Therefore, implementing effective strategies specifically focused on solid-waste management using environmentally friendly methods like reusing and recycling must be implemented urgently across all sectors globally. Furthermore, economies like Indonesia are greatly dependent on attainable power supplies, just as developing industrialization endeavors rely heavily on continuous energy sources. Therefore, financial resource allocation acquires paramount significance when considering capital investments needed for necessary infrastructure requirements. Thus, successful adoption would necessitate adopting a comprehensive strategy incorporating economic, technical, and environmental considerations. In conclusion, the implementation of effective solid waste management strategies that are environmentally friendly and inclusive of renewable energy sources is critical to attaining a cleaner and more sustainable future for Indonesia and the world at large.

Policymakers in Indonesia and other nations must prioritize sustainable green initiatives that reduce reliance on nonrenewable fossil fuels. The conventional methods currently used for generating electricity and meeting industrial needs result in high levels of carbon emissions, which have a detrimental impact on the environment. It is possible to collaborate and reduce carbon emissions while advancing energy resilience through sustainable investments. This approach also allows for economic growth that benefits future generations.

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